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ABSTRACT

The development of pupil behavior in the process of creative problem solving was investigated. A battery of pretests and post-tests (including written compositions, oral compositions, and open stories) was developed and administered as part of a program to develop cognitive skills. Treatment groups received instruction for 30, 60, or 90 minutes per week for 23 weeks. Results from 200 fifth-grade subjects in a total of 24 classes (six classes in each of the four treatment groups) significantly favored two experimental groups. These were (1) the group receiving the basic treatment in problem solving plus extra training in abstract thinking and (2) the group receiving the basic treatment plus extra practice in problem solving. These two groups also showed similar results when high, medium, and low IQ levels were analyzed. Tables, figures, and references are given. (Author/DE)

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PROMOTING GROWTH IN PROBLEM SOLVING IN AN INTEGRATED PROGRAM OF LANGUAGE SKILLS FOR THE FIFTH GRADE

Abstract

In an experiment a battery of pretests and posttests was developed and administered as part of a 23-week program in the cultivation of cognitive skills. Results obtained from 200 Ss scores in a total of 24 classes, 6 classes in each of 4 treatment groups, were significant for overall tests ($p < .01$) and for planned contrasts in favor of two experimental groups: (a) a group receiving the basic treatment in problem solving plus extra training in abstract thinking and (b) a group receiving the basic treatment plus the extra practice in problem solving. A supplementary analysis of high, medium, and low IQ levels indicated similar results.

PROMOTING GROWTH IN PROBLEM SOLVING IN AN INTEGRATED PROGRAM OF LANGUAGE SKILLS FOR THE FIFTH GRADE[1]

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Problem solving has been used to refer to such a wide diversity of behavior that it is a poorly defined, although frequently stated, goal of elementary education. Creative behavior in problem solving has been described by various authorities, for example, Guilford (1967), Getzels (1964), and Russell (1956, 1965). The creative aspect is distinguished by Guilford as a divergent dimension--a way of generalizing information from given data. In a divergent thinking sequence individuals are free to generate independently their own data within a data-poor situation. Individuals may take a new direction or gain a new perspective.

In agreement, Getzels has defined the creative dimension in problem solving as related to the number of knowns and unknowns in the situation. He suggests strongly that school problems be full of unknowns both as to the problem and as to the solution, at least for the pupil. He suggests that too often in school there are problem situations and measurement where both pupil and teacher know what the problem is and what the one right answer is. Thus, the pupil behavior is a matter of rote drill.

Russell (1956, 1965) distinguished six basic mental processes: (a) perceptual thinking, (b) associative thinking, (c) inductive-deductive thinking leading to concept formation, (d) creative thinking, (e) critical thinking, and (f) problem solving. It appeared that the other five processes might be found interrelated meaningfully during problem solving which was organized with high consciousness and orientation toward a goal perceived by the child. But perhaps the best and most recent exposition of the "problem with 'problem solving'" is presented in a review by Keislar (1969) for the school setting.

The present investigator could find no study that had tried to construct tests designed to evaluate a program to cultivate a problem-solving process including a creative dimension within a program of integrated language skills in the elementary school. As well as being academically oriented, the present program was intended to be "people oriented" so that the portion of the problem-solving process dealing with application of principles (Bloom, 1956) dealt with human relations that might be used by children. The integrated language skills program is described in detail elsewhere (Lundsteen, 1968).

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Accordingly, the major concern of this study was to assist and to evaluate development of pupil behaviors in the process of creative problem solving. Integrated into the rationale and behavioral objectives were opinions from the previously cited authors and others (Rickborn and Lundsteen, 1968). The terminal behavior of creative problem solving involved 12 steps, ordered flexibly, and 7 qualities. The qualities were incorporated into a judgmental scale. An experimental study was conducted in order to manipulate training for the assistance of the problem-solving process and two related subabilities: (a) skill in listening and (b) skill in employing an abstract level of thinking. In a gross way an attempt was made to deal with learning hierarchies according to the theory suggested by Gagné (1966). Parenthetically, Gagné has used the tern "subcapability" to label a skill which is subsidiary to some terminal behavior. In this report the term is shortened to "subability."

The first task in this investigation was to see if there was any significant difference between the experimental groups that received the problem-solving training and the control groups that did not. The controls followed the state prescribed curriculum for Santa Barbara County, California. A second task was to determine what each of the three experimental treatments might contribute. The experimenter predicted that the treatment including not only problem solving but also abstract thinking would have the highest payoff, probably even higher than the group assisted with listening skills. See Table 1 for a representation of the four treatments. The stimulus for the Wednesday problem-solving treatment was presented via television. The second control group had postests only.

Method

Subjects

From a pool of 45 volunteer classes, 6 were assigned randomly to each of the 5 treatment groups. For the judged battery of three tests of problem solving, a subsample was selected randomly from each class. In the final analysis N equalled 200 Ss. (See Table 1 for the indication of N in each group.)

Instruments

In this section is presented each of three criterion measures of problem solving and information on (a) how the student reported his knowledge, (b) the nature of the question asked or the "display," (c) the judgmental continuum or scale used to assess the quality of performance during the profile of the 12-step sequence, and (d) the method of scoring.

For the first measure, the Oral Composition Task of Problem Solving (OCOM), the student reported by speaking into a microphone. The E used small transistor tape recorders which children experienced for

Table 1

Basic Elements for Treatment Groups

Category	Experimental Treatment 1		Experimental Treatment 2		Experimental Treatment 3		Controls 1 & 2
Number of Classes	6 classes		6 classes		6 classes		6 classes ea.
Number of Ss	(N = 41)		(N = 45)		(N = 39)		(N = 75)
Content of Curriculum	Problem-solving	Practice of problem-solving concepts	Problem-solving concepts	Listening skills	Problem-solving concepts	Qualitative levels of thinking	State prescribed curriculum and texts
Intensity of training	Two 30 min. lessons	One 30 min. lesson	Two 30 min. lessons	One 30 min. lesson	Two 30 min. lessons	One 30 min. lesson	Three 30 min. lessons
Duration	23 wks.	23 wks.	23 wks.	23 wks.	23 wks.	23 wks.	23 wks.
Weekly Schedule	Tues., Wed.	Thurs.	Tues., Wed.	Thurs.	Tues., Wed.	Thurs.	Tues. Wed., Thurs.

several weeks before the testing. The S was asked to name as many as three problems he might have with a friend or with people. Next, he was to pick one of his problems and tell how he might go about solving it. It was hoped that the verbally capable child that could not write well would have an opportunity to display his skill. The tapes were typed and the responses judged.

The first chart shows the steps and a tentative instructional hierarchy and the second chart shows the judgmental scale of qualities which was applied to both the oral and the written compositions and also a tentative instructional hierarchy. The grouping and labeling step (Item 7 in the first chart) was omitted for Tasks 2 and 3. Instead, the number of hypotheses was counted as an index of fluency, and also the quality of the hypotheses was examined. With three judges, the S could accumulate as many as 180 points. To make as many as two points ("fair," corresponding to Quality 2) on the scale, the S simply had to construct a literal, relevant statement corresponding to Quality 1 in the second chart. For example, "Tommy's problem was that he messed up his neighbor's patio," would be classified as representing Quality 1. Test-retest reliability was .52 (N = 27), and the mean interrater reliability was .88 for three judges (N = 200). A total rating as high as 180 was possible for both this measure and the second measure.

For the second measure, the Written Composition Task of Problem Solving (WRIC), the S reported his skill by writing on paper. Otherwise, this task was exactly the same as the first and was judged using the same scale. Test-retest reliability was .53 (N = 26), and the mean interrater reliability was .87 (N = 200).

For the third measure (the open stories) called Tell the Problem and Make a Plan (OPST), the S again reported his knowledge by writing. But he was stimulated by an unfinished story, rather than having to furnish his own data. Also, he was given 12 stimulus questions to aid in his construction of responses to the 12 steps in problem solving described earlier. Test-retest reliability was .74 (N = 26), and the mean interrater reliability was .90 (N = 200).

The stories were all about boys who had problems such as relating to their peers, coping with feelings of guilt, with poor self-picture, and with living up to parents' expectations. There were 24 items in all, with two chances to respond to each type of question. With three judges, the S could accumulate as many as 1,224 points, with generally 2 points for each question and for each category.

The rating criteria were stated in performance language. (See Chart 2.) Names for the objectives included: (a) Comprehension, (b) Relevance, (c) Elaboration, (d) Originality, (e) Multiple Alternatives, (f) Empathy, (g) Causal Thinking, (h) Testability of Hypotheses, and (i) Evaluation. Thus, the S was measured not only on a pass-fail basis (i.e., Did he respond to the step or not respond to the step?), but also attempts were made to assess a hierarchy of qualities concerning the responses. Also an analysis of difficulty level of the 12 question types has been made for this measure. (See Table 6.)

Chart 1

TWELVE STEPS OR QUESTION TYPES USED IN THE TESTS
FOR CREATIVE PROBLEM SOLVING

1 Main Problem. The pupil constructs a problem.

2. Subproblems. The pupil names or constructs subproblems that go with the main problem or are a part of it.

3. Definition. The pupil defines (describes) key terms in the problem situation which he constructed and/or clarifies these terms.

4. Type of problem. The pupil identifies (distinguishes) the problem as to type or kind.

5. Hypotheses. The pupil constructs hypotheses.

6. Facts and conditions. The pupil names, describes, and distinguishes facts and conditions in the situation which he constructs that might be helpful when seeking a solution to the problem.

7. Classification of facts and conditions. The pupil distinguishes, groups or classes and names the class(es) under which the various facts and conditions might be categorized.

8. Missing data. The pupil names and/or describes and/or distinguishes missing information that is needed to solve the problem.

9. Search strategy. The pupil constructs a method(s) for finding the information that is missing.

10. Statement of principle. The pupil states a principle for solving a problem of the type he indicated.

11. Application of principle. The pupil applies the principle to the problem situation, describing the application.

12. Planned evaluation of hypothesis. The pupil identifies one of his constructed hypotheses for solving the problem and constructs an evaluation by supporting his choice with reasons in regard to confidence in probability and/or consequences.

Block Diagram

TENTATIVE LEARNING HIERARCHY FOR THE INSTRUCTIONAL SEQUENCE IN PROBLEM-SOLVING BEHAVIORS

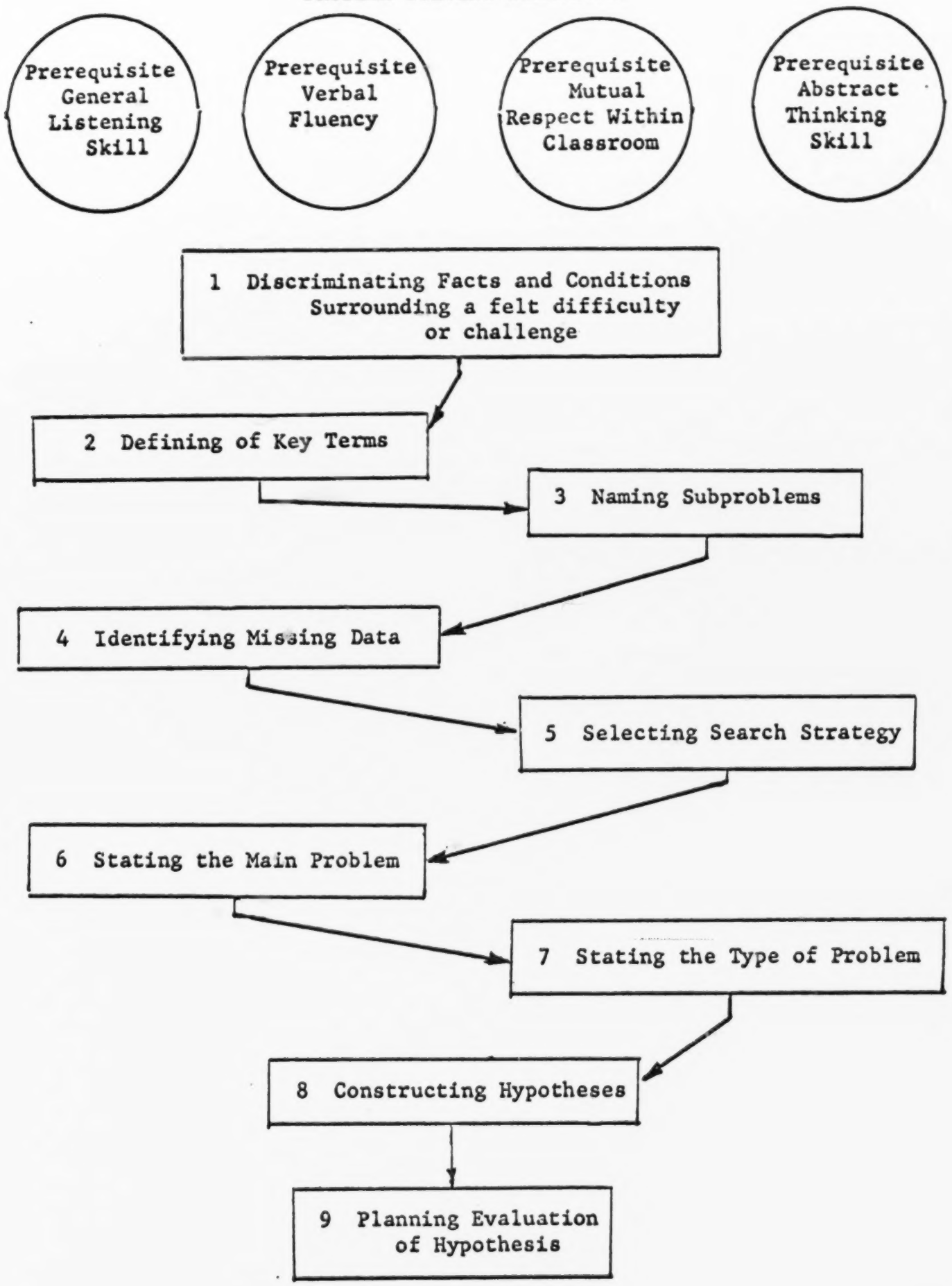

Prerequisite General Listening Skill
Prerequisite Verbal Fluency
Prerequisite Mutual Respect Within Classroom
Prerequisite Abstract Thinking Skill
1 Discriminating Facts and Conditions Surrounding a felt difficulty or challenge
2 Defining of Key Terms
3 Naming Subproblems
4 Identifying Missing Data
5 Selecting Search Strategy
6 Stating the Main Problem
7 Stating the Type of Problem
8 Constructing Hypotheses
9 Planning Evaluation of Hypothesis

Chart 2

QUALITIES OR TRAITS SOUGHT FOR RESPONSES DURING PROBLEM SOLVING

1. Literal Comprehension (Prerequisite): The child identifies, names, describes and/or constructs a response showing plain, literal comprehension of specifics. (Reference: Bloom, 1956, Taxonomy of Educational Objectives, Cognitive Domain Level 1.) Note: Initially the instructor has the responsibility to determine if the stimulus, e.g., story episode, is sufficiently relevant to the child so that literal comprehension is possible. Later, the child has part responsibility for transforming unfamiliar problems into the familiar.)

2. Relevance: The child identifies...constructs a response showing a connection to the stimulus or story, or that he has "stuck to the topic" rather than "going off into the wild blue yonder," not to return. (Note: The instructor is cautioned, however not to shut off thinking, especially of the timid child, when guiding the discipline of relevance necessary to a goal oriented task. Again, in the first place the goal needs to be relevant to the child, e.g., the child needs to sense a problem. (Bloom, 1956, Taxonomy level 1)

3. Elaboration: The child identifies...constructs a response with details, examples, and descriptions which indicates fluency and which amplifies or enlarges upon the step in the problem-solving process. The response may have been stimulated by a question from the instructor. (Bloom, 1956, Taxonomy Level 2).

4. Originality: Child identifies...constructs a response which is unique or unusual, new or different in the class or group in which he is judged. Generally, others have not thought of the response. The response has not been one repeated by others and is not a limiting mental set. The response may indicate free reign given to speculation and fantasy. (Guilford, 1967, divergent dimension).

5. Multiple Alternatives: The child identifies...constructs a response showing an understanding of several alternatives rather than just one. His response shows understanding that goes below surface or literal events to inference making. The response does not represent inflexible, rigid thinking, e.g., giving one right answer, using words such as "always" and "never" to make over generalizations or getting in a corner. (Guilford, 1967, products of implications).

6. Empathy: The child identifies...constructs a response in which he appears to put himself in another's position or role. He appears in his verbalization to show a feeling for or sympathy for someone else besides himself or an acceptance or preference for this value. (Krathwohl, 1964, Affective Domain, Level 3 Valuing)

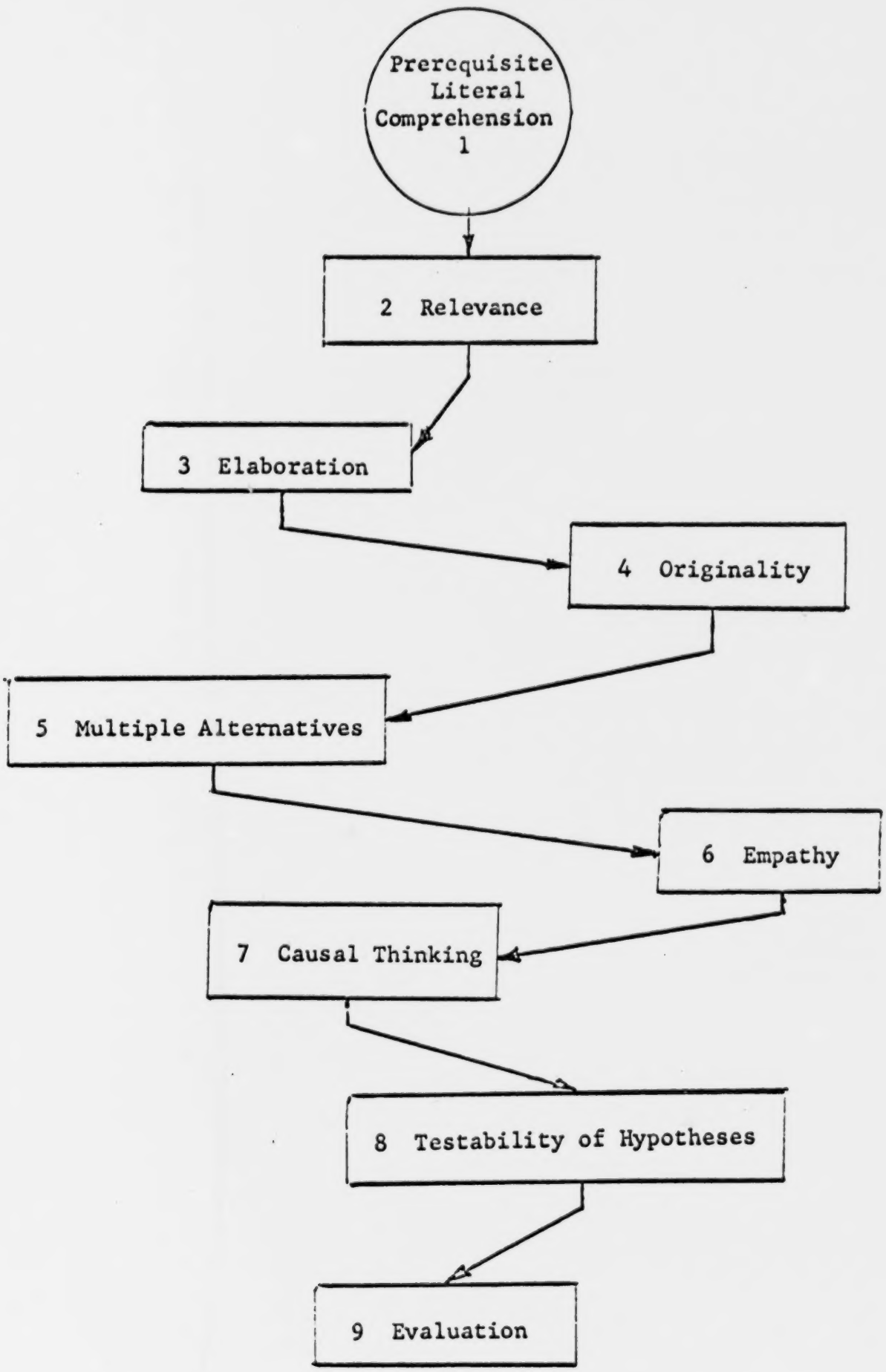
7. Causal Thinking: The child identifies...constructs consistently a response showing a relationship between cause and effect. He tries to tell why or for what reason events may have happened. He gives an insightful explanation. Answers may range from simple to complex, from those showing logical inadequacies to those showing validity. This kind of thinking frequently is prompted after an hypothesis for solving the problem has been selected for a plan and is justified as to why it might work best. (Guilford, 1967, products of relations)

8 Testability of Hypotheses: The child identifies...constructs responses for solving a problem which would be possible to assess, observe, measure, responses which are usable, feasible, or practical. The child produces ideas which he could examine systematically and critically. (Bloom, 1956, Taxonomy Level 3--application)

9. Evaluation: The child identifies...constructs a response showing judgmental effort with a conscious criteria--external consensus or internal logic--and he supports his critical thinking with reasons for his judgment which may deal with confidence in probability or consequences. Ability to give reasons is taken as evidence that the judgment was not "snap" or premature but was highly conscious or shows "planfulness." (Bloom, 1956, Level 6--evaluation).

Block Diagram

A TENTATIVE HIERARCHY FOR TEACHING THE QUALITIES OR TRAITS SOUGHT FOR RESPONSES DURING PROBLEM SOLVING



Procedure

After the battery of pretests, only 3 of which are considered in this report, 23 weeks of instruction followed for the 4 different tracks. (See Table 1.) For the three experimental groups, special training materials were constructed and distributed to appropriate groups of teachers. A concept map or developmental hierarchy was made for the problem-solving treatment from the list of 12 steps and the 9 qualities sought. (See Charts on pages 5 and 7.) A portion of the hierarchy was distributed in each of the training lessons and repeated at planned intervals.

Teachers were trained in the use of the experimental materials five days before school started, once monthly in the evening, and were visited by observers once monthly. Efforts were made to see that possible Hawthorne effects associated with other research projects and inservice training were also operating for the group designated as control so as not to bias, relatively, results obtained from teachers using the special materials. The control teacher programs were reported on questionnaires. After pupils received the battery of posttests, analyses were made using the analysis of variance and Scheffé tests.

Results

Table 2 shows the means and standard deviations for the three problem-solving variables. Table 3 gives the analyses of variance for the three variables. From Table 3 it can be noted that the control group (C1) had the advantage at the beginning of the experiment. The experimental groups were behind, but at the end they were ahead on every measure.

There were four treatment groups which completed both pretest and posttests, E1, E2, E3 and C1. A fifth treatment group, C2, had posttests only. There was no significant difference between C1 and C2 on any measure. Symbols refer to the experimental groups having (a) extra practice in problem solving, (b) the listening emphasis, (c) qualitative levels of thinking, especially abstract, and (d) the control group with pretests, in that order. Simple inspection indicated that there was no marked departure from normal distribution for any group. Analysis of variance and F-test are supposedly "robust" with respect to the departure from the assumption of homogeneity of variances. According to inspection, differences in standard deviations were not as great for the posttests upon which the analyses were made.

The hypothesis regarding comparison of treatment groups on the criteria for creative problem solving appeared to be generally confirmed. As can be seen in Table 3, differences were significant for all three of the problem-solving measures. The results from a supplementary analysis, Scheffé tests, were significant as follows.

WRIC. For the written composition the highest mean was that of the experimental treatment group with extra practice on problem solving (E1).

Table 2
Means and Standard Deviations for Pretests and Posttests
For Three Tests of Creative Problem Solving

Test	Experimental Treatment 1 (N = 41)		Experimental Treatment 2 (N = 45)		Experimental Treatment 3 (N = 39)		Control 1 (N = 37)	
	M	SD	M	SD	M	SD	M	SD
Pretest								
WRIC	46.6	5.4	46.8	4.1	47.6	4.9	51.5	7.6
OCOM	48.8	6.3	46.7	5.9	46.9	6.3	43.0	14.2
OPST	180.9	60.5	159.6	53.1	136.7	62.8	216.6	84.6
Posttest								
WRIC	60.3	13.7	55.3	5.8	55.4	8.0	52.4	7.8
OCOM	56.0	9.7	55.4	7.6	59.5	8.2	48.0	13.8
OPST	331.5	89.2	275.4	94.3	353.4	132.2	271.4	97.7

Note.--Abbreviated: WRIC = written composition on a problem, OCOM = oral composition on a problem, OPST = open-ended story with 12 questions.

Table 3
Analyses of Variance for Scores on Three Posttest Measures
Of Creative Problem Solving

	Source	df	MS	F
WRIC	Treatment	3	426.0	4.9*
	Error	158	86.4	
OCOM	Treatment	3	890.2	8.9*
	Error	158	99.8	
OPST	Treatment	3	66827.6	6.1*
	Error	158	10868.4	

Note.--N = 162 (a randomly drawn subsample from each class). Abbreviated: WRIC = written composition on a problem, OCOM = oral composition on a problem, OPST = open-ended story with 12 questions.

*$p < .01$.

E1 > the listening emphasis group (E2) ($p < .10$), E1 > the control (C1) ($p < .01$).

OCOM. For the oral composition the highest mean was that of the treatment group with the emphasis on qualitative levels of thinking, especially abstract (E3). E1 > C1 ($p < .01$), E2 > C1 ($p < .05$), E3 > C1 ($p < .01$).

OPST. For the open stories with 12 types of questions the highest mean was that of the group with the emphasis on qualitative levels of thinking (E3). E1 (extra practice) > C1 ($p < .10$), E3 > E2 (listening) ($p < .05$), E3 > C1 ($p < .05$).

A supplementary analysis was made for the high, medium, and low IQ levels using all five treatment groups having posttests. On all three measures of creative problem solving significant differences were found in favor of one of the experimental treatments. Usually the favored treatment was the one with the emphasis on abstract thinking or the one with the extra practice on problem-solving concepts. See Table 4 and Table 5.

Another supplementary analysis was made using the intact class as the unit of observation ($N = 24$ class means). For the four treatment groups the only significant difference, with this loss of statistical power, was for the oral composition. On OCOM, $p < .05$ ($F = 4.11$, $df = 3/20$. The mean for the experimental group with the abstract emphasis (E3) > the control (C1; $p < .05$), according to Scheffé's test. Supplementary analyses were also made using analysis of covariance (IQ and IQ and pretest) and results were essentially the same as all of the results for the analyses of variance. At the time of the present writing it is not possible, however, to use Scheffé test after analyses of covariance, according to communication with Scheffé.

Discussion

The hypothesis of no treatment differences on the criteria of problem solving was rejected. Supplementary analysis by means of Scheffé tests indicated that the group trained not only in the core program of problem solving but also on the subability of qualitative levels of thinking with emphasis on abstract thought (E3) had the highest mean for two out of the three problem-solving tests. These tests were the oral composition and the open-ended stories with 12 stimulus questions. The significant contrasts against the control group was consistently in favor of the experimental group. However, on the open-ended stories the group with the abstract training was also significantly higher than the group with the listening emphasis.

It might be implied that in the case of the written composition, the advantage naturally lay with a problem-solving treatment which simply included extra practice. All experimental groups which all had a basic program in problem solving produced higher means than did the control group with no systematic training.

Table 4
Analyses of Variance for Scores on the Posttest Measure of Creative Problem Solving According to Three Levels of Mental Ability Utilizing All Five Treatment Groups

Criterion and Level	Source	df	MS	F	Scheffé Test
WRIC					
Hi IQ	Treatment	4	593.1	5.8***	E1[a] > E2[b]**, E3[c]*
(111-146)	Error	61	101.5		C1[d]***, C2[e]**
Medium IQ	Treatment	4	109.0	2.6**	
(96-110)	Error	61	42.1		
Low IQ	Treatment	4	53.7	1.7	
(62-95)	Error	63	32.3		
OCOM					
Hi IQ	Treatment	4	526.5	6.6***	E1 > C1***
	Error	61	79.6		E3 > C1***
Medium IQ	Treatment	4	446.0	3.4***	E2 > C1**
	Error	61	130.7		
Low IQ	Treatment	4	263.8	3.3**	E3 > C1**
	Error	63	79.9		
OPST					
Hi IQ	Treatment	4	20453.9	2.3	E3 > C1*
	Error	61	8956.9		
Medium IQ	Treatment	4	31878.9	3.8***	E3 > E2**
	Error	61	8319.8		E3 > C2**
Low IQ	Treatment	4	33021.0	4.9***	E1 > C1*, E1 > C2**
	Error	63	6740.3		E3 > C2*

* $p < .10$ (used in connection with Scheffé tests only)
** $p < .05$
*** $p < .01$

[a] E1 = extra problem-solving practice
[b] E2 = listening emphasis
[c] E3 = abstract thinking emphasis
[d] C1 = control with pretest
[e] C2 - control with posttest only

Table 5
Means for Posttests for Three Tests of Creative Problem Solving
For All Five Treatment Groups at Three IQ Levels

Test and IQ Level	E1 M	E2 M	E3 M	C1 M	C2 M
WRIC	(N = 15)	(N = 14)	(N = 17)	(N = 12)	(N = 8)
Hi	70.3	57.4	59.6	53.9	54.4
Med	(N = 13) 56.5	(N = 16) 56.9	(N = 7) 57.1	(N = 14) 55.3	(N = 16) 50.6
Lo	(N = 13) 52.7	(N = 15) 51.5	(N = 15) 49.9	(N = 11) 47.1	(N = 14) 49.8
OCOM					
Hi	62.7	55.8	62.4	48.3	52.1
Med	52.2	58.2	60.0	50.7	45.3
Lo	52.7	52.0	56.1	44.3	48.1
OPST					
Hi	375.5	353.9	407.4	304.1	343.1
Med	322.0	255.3	399.1	307.4	264.4
Lo	290.3	223.5	270.9	190.0	175.5

The finding with respect to the treatment with training in abstract thinking corresponds to opinion, data, and recommendations for training reported, for example, by Bruner (1964) and Levi (1966). A description of the tests of abstract thinking and listening is given elsewhere (Lundsteen and Michael, 1966).

It may be supposed that further attention to test construction and curriculum building in the general area of problem solving and in the particular area of assisting the abstract thinking subability may aid development of pupil skills. It is recommended that training be investigated at beginning grade levels as well as the fifth-grade level used in the present study.

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Table 6

ANALYSIS OF DIFFICULTY LEVEL OF TWELVE QUESTION TYPES FROM THE PROBLEM-SOLVING MEASURE, OPST FOR PRETEST AND POSTEST EXPERIMENTAL GROUP ONLY

Low IQ $\underline{N}$ = 60
High IQ $\underline{N}$ = 65

IQ Group	Question No.	Pretest$_1$ $\underline{M}$	Postest$_2$ $\underline{M}$	Rank$_1$	Rank$_2$
Low	1	20.13[a]	25.28[a]	1	1
	2	17.97	25.18	3	2
	3	15.33	18.53	5	10
	4	14.93	21.80	6	5
	5	18.43	24.36	2	4
	6	14.37	19.74	9	7
	7	11.97[b]	16.79[b]	12	12
	8	14.87	21.67	8	6
	9	13.53	17.90	10	11
	10	14.93	19.64	7	8
	11	12.70	19.21	11	9
	12	16.43	24.92	4	3
High	1	24.19	37.28	2	3
	2	23.72	37.16	3	4
	3	19.65	28.53	7	10
	4	20.12	33.47	5	5
	5	23.51	38.94	4	2
	6	19.42	33.38	8	7
	7	14.95[b]	21.94[b]	12	12
	8	20.03	33.41	6	6
	9	17.45	27.19	11	11
	10	18.95	31.44	9	9
	11	18.34	32.84	10	8
	12	24.55[a]	43.66[a]	1	1

[a] The questions for the problem-solving measure (OPST) were ranked from highest to lowest according to the mean score that high IQ and low IQ pupils in the experimental group were able to achieve. For pupils in the low IQ division, the highest mean score was made on question 1 (constructing a main problem) on both the pretest and the postest. For pupils in the high IQ division, however, the highest mean was made on question 12 (planned evaluation of hypotheses) on both the pretest and postest. See Chart 1 for a description of the 12 question types. Comparison of pre- and postest ranking of all 12 question types, from highest mean score to lowest mean score for the low IQ group, yielded a rank-difference coefficient of correlation of .84, and for the high IQ group, .93.

[b] For pupils in the low IQ division and in the high IQ division the lowest mean score was made on question 7 (classification of facts and conditions) on both the pretest and the postest.

APPENDIX

Practice on scoring the task, Tell the Problem and Make a Plan. Let's try a practice exercise to see if you can score this fifth-grade child's answers to questions concerning an unfinished problem story. Use your cover sheet so that you will not see our judgment until you have had an opportunity to try to construct your own. Review the steps and the qualitative rating of steps within the scale for Tell the Problem and Make a Plan located on page 19 before you try to judge. Please mark the appropriate box with an "X." We had better give you at least an abbreviated version of the first story (or you may prefer to read the entire story located in the appendix). Dotted lines ... indicate omissions.

Tell the Problem and Make a Plan

Version C, Openended
Story 1

Two boys were huddled in the corner of their classroom, heads bent low over their science project--an incubator. Finally Jerry speaks.

"Say, do you think something can be the matter? Our chicken eggs should have hatched by now, and they haven't."

"Well, for Pete's sake don't tell my cousin Tommy," said Bob.

"Why not?"

"You know the way he 'fixed' the volcano we made in class!"

"Oh, yeah, it wasn't erupting smoke, so he held a match to it. There was plenty of smoke then all right--nothing but smoke." ...

"He should be locked up."

"No, he's a good kid, most of the time. I really think he's a smart kid. He never sits still though. ...

"Back to our chicken eggs. It may be that the temperature is still too low, even though we put in that extra volt light bulb."

"Or it may be it's too hot now," said Bob. "We need to rig up some ventilating system, a small electric fan might do it. ...

"Oh, no! Here comes Tommy!" said Bob.

"Hi fellas. - - Hi fellas! - - HI FELLAS!!"

"Hello, Tommy," both boys finally replied.

"Oh, it's your chicken eggs - - haven't hatched yet, huh? I know what to do. [There's a hammer here.] I know <u>just</u> what to do!" ...

Here is a judgmental scale for you to use.

Here is the first question which is followed by a fifth-grade child's written response to that question.

<u>Question 1.</u> (Facts and conditions)
We are going to put our attention on Tommy, the one the boys were talking about, the child who had the hammer. You may have some idea that Tommy has a problem. If he has a problem list the pieces of information in the story that might be helpful to Tommy in solving his problem. Write as many pieces of information that you notice as you can. Write the facts in the story that might work to help Tommy.

Child's response:

<u>Question 1</u>. *I think some helpful things I noticed were that his cousin said he was really a good smart kid. He didn't want to lock him up. Jerry had an idea to get Tommy to stop and think first, and Bob said he should try that... and even started to say "we can help you learn..." That's not much but I guess it's better than nothing.*

(Use a cover sheet for the bottom half of page 20.)

Figure 8.
JUDGE'S SCALE AND SCORING DEVICE
for the measure
TELL THE PROBLEM AND MAKE A PLAN

Check one:
Pretest ☐
Postest ☐

Put an "X" in the appropriate box if the quality being rated is present. For each "X" given, count two points. Enter the total score in the boxes for each question in the column at the end where it says QUESTION TOTAL. Even if the response is incomprehensible or the child did not respond at all, give one point in total so that there are no zero scores.

Quality	Questions for Story #1											
	1	2	3	4	5	6	7	8	9	10	11	12
1. LITERAL COMPREHENSION: response shows question understood										6th grade only		
2. RELEVANCE: response shows a connection to story; "sticks to topic"												
3. ELABORATION: response shows fluency and details or describes												
4. ORIGINALITY: response is unique or unusual in the group												
5. MULTIPLE ALTERNATIVES: response shows understanding of several alternatives												
6. EMPATHY; response shows child putting himself in another's place or role												
7. CAUSAL THINKING: response tells why or for what reason events may have happened												
8. TESTABLE HYPOTHESES; response possible to assess, observe; usable, feasible												
9. NUMBER OF HYPOTHESES (write number and add in as part of score)												
10. EVALUATION: response shows judgmental effort to evaluate hypotheses with at least implied criteria and with supporting reasons or evaluative thinking on other steps												
QUESTION TOTAL												

Pupil Name_____ Code # ____ Story I Total ☐

Teacher Name_____ Code # ____ Judge Name_____

(Spaces lined out indicate that quality does not apply)

Using your Judge's Scale and Scoring Device for "Tell the Problem and Make a Plan," how would you rate this answer to that question (page 18) number 1 on facts and conditions? Put an "X" (or a "2") in the boxes if the quality was present. Then enter the question total in the box at the bottom. Each quality checked gets 2 points.

(Qualities 8 and 9 do not apply to this question or the next ones until you get to question #8.)

Quality	Question 1
1. Literal comprehension	
2. Relevance	
3. Elaboration	
4. Originality	
5. Multiple alternatives	
6. Empathy	
7. Causal thinking	
...	
10. Evaluation	
Question Total	

STOP until finished marking the boxes. Thank you.

Answer: Here is the way we scored. You may or may not agree.

Quality	Question 1
1. Literal comprehension	X
2. Relevance	X
3. Elaboration	X
4. Originality	
5. Multiple alternatives	X
6. Empathy	
7. Causal thinking	
...	
10. Evaluation	X
Question Total	10

We felt that for this question-step that the response showed (1) comprehension of what the question was asking for, (2) that the response was relevant to the story material given as well as to the question, (3) that the response showed several facts and conditions giving elaboration as well as (5) multiple alternatives, and, although we did not feel very strongly about this, we decided that the last sentence showed some (10) evaluative thinking. As each of the 5 "X"s was worth 2 points, the total for the question was 10. When there was uncertainty we consistently gave the response the benefit of the doubt, or a mark. (Numbers in ( ) refer to the scale.)

(Use a cover sheet for bottom half, next page.)

Please go to the next question and response.

You may wish to transfer your scoring to page 19 into the first column.

Here is the second question which is followed by a child's written response to that question based on the same story.

Question 2. (Definition)
Here is an idea that is related to that story. The idea is "problem solving." How would you define or tell the meaning of the words "problem solving"? Write your answer.

Child's response:

Question 2. *I think it means how you think you could stop what you want to stop, or to work out an arithmetic problem, or a trouble between friends.*

Using your Judge's Scale and Scoring Device for "Tell the Problem and Make a Plan"given you on page 19 , mark the boxes if you feel the quality is present in the child's response. Be sure you mark in the second column for question 2.

STOP until finished marking the boxes on page 19 column 2. Thank you.

Answer: Here is the way we scored. You may or may not agree.

Quality	Question 2
1. Literal comprehension	X
2. Relevance	X
3. Elaboration	X
4. Originality	
5. Multiple alternatives	X
6. Empathy	
7. Causal thinking	
...	
10. Evaluation	
Question Total	8

We felt that for this question or step that the response showed (1) comprehension of what the question required, (2) that the response was relevant to the question and to the story context. Because of examples "arithmetic problem" and "trouble between a friend," we marked the quality of (3) elaboration. And because alternative meanings of "problem solving" were implied we marked the box for (5) multiple alternatives. Thus on this question the response earned a score of 8. (2 points times 4 qualities = 8)

Please go to the next question and response. (Use cover sheet for bottom half of this page.)

Here is the third question which is followed by a child's written response based on the same story.

Question 3. (Subproblems)
What are some of the smaller problems or parts of problems that Tommy has in this story? Remember we are thinking about Tommy. You can look back at the story if you need to. Write your answer.

Child's response:

Question 3. *I think some of his small problems were that he had burned up a volcano, and I bet he got in trouble about the cat and the lillies, and Jerry doesn't seem to like him, and the boys didn't want to tell him anything or talk to him. He may feel bad and not understand and no one tells him. He doesn't do things the smart way; he does it the nutty way.*

Using your 10 point Judge's Scale and Scoring Device on page 19 mark the box for each quality you feel is present in the child's response. Be sure to mark in the third column for question 3.

STOP until finished marking the boxes. Thank you.

Answer: Here is the way we scored. We felt that the response showed (1) comprehension of what the question required, that the response was (2) relevant to the question and to the story context. We felt that there were details for (3) elaboration rather than a flat statement. We might have trouble defending this, but in the group of papers we judged, we felt that the last sentence was a rather (4) original or unique way to express the subproblem (line 6). In line 4 and 5 we thought we detected (6) empathy or an understanding of how Tommy might feel. Consequently, on this question the response earned a score of 12.

Quality	Question 3
1. Literal comprehension	X
2. Relevance	X
3. Elaboration	X
4. Originality	X
5. Multiple alternatives	X
6. Empathy	X
7. Causal thinking	
...	
10. Evaluation	
Question Total	12